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A METHOD FOR APPRAISING FOREST FIRE DAMAGE IN

SOUTHERN APPALACHIAN MOUNTAIN TYPES. 3.106

A Progress Report

By

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INTRODUCTION

An average of 11,000 forest fires occur each year in the southern Appalachian mountains.^{2/} For many reasons the resulting damages are appraised in terms of dollars by the public and private agencies responsible for forest fire protection activities. The need for making these appraisals preceded development of accurate knowledge of the ways in which fires damage Appalachian mountain types and the extent of the

^{1/}Assistance in the preparation of this technical note was furnished by personnel of the Works Progress Administration, Project No. 765-32-3-3.

^{2/}Based on reports for the 5-year period, 1933-1937, incl. U. S. Dept. Agr., Forest Service, Washington, D. C.

dollar damage done by fires of varying intensities burning in different forest types and conditions. Because of the pressure of immediate necessity, each protection agency has been forced to use its best judgment in setting up scales of forest fire damages and methods of appraisal. As a result, there is considerable variation in methods and in the actual values used to determine damage. For example, one method assumes that damage is done only when merchantable timber is killed; another is based on the concept that most forest fire damage is done to young growth, and that losses in merchantable stands are negligible. There is general agreement that present methods could be improved by careful study of the true nature of forest fire damage.

Completion of recent studies in the major Appalachian mountain types has resulted in determination of a single set of damage figures for the type, condition class, and fire intensity combinations most frequently encountered. These figures are presented in Table 1. They summarize the total losses resulting from the three major sources of damage to timber values by fires in mountain types. These sources are:

1. Mortality, or losses resulting from fire-killed trees, including both merchantable and below merchantable sizes.
2. Rot which enters fire wounds on surviving trees and, for certain of them, eventually results in "long butts" and other volume losses.
3. Reduction in the rate of diameter growth of surviving, but fire-wounded trees. This is much less important than 1 and 2.

Table 1.-Average damage per acre in dollars.

Fire danger:	Class-2	Class-3	Class-4	Class-5
severity	(low)	(medium)	(high)	(extreme)
Condition	Sawlog	Under-	Sawlog	Under-
class	sawlog	sawlog	sawlog	sawlog
Stocking	HARDWOOD TYPES			
Good	0.30	0.55	0.85	1.40
Medium	0.35	0.45	0.90	1.15
Poor	0.40	0.40	1.00	1.05
Stocking	PINE-HARDWOOD TYPES			
Good	0.35	0.60	1.00	1.50
Medium	0.40	0.55	1.10	1.35
Poor	0.50	0.50	1.20	1.25
Stocking	PINE TYPES			
Good	0.25	0.35	0.70	0.90
Medium	0.30	0.35	0.75	0.90
Poor	0.30	0.35	0.85	0.85

The figures in Table 1, therefore, are confined to losses in tangible values of trees of commercial species, including both merchantable trees and those below merchantable size which can reasonably be expected to become a part of the future crop. Extremely important are damages to intangible forest assets, such as aesthetic, recreational, and watershed values, and loss in income of industries and workers

dependent on forest products, but these losses are not included in the proposed system as no means have yet been established for their determination. Therefore, until such means can be developed by additional study, appraisal of fire damage to intangible values must continue to be based primarily upon judgment and arbitrary decision rather than fact. Where a protection agency chooses a method requiring the appraisal of damages to both tangible and intangible values, perhaps the best that can be done now is to set a flat figure representing the best opinion on damage to intangibles and add this to the damages determined for tangible values, unless a more detailed method for classifying intangibles is in practice.

BASIS OF PROPOSED FIRE DAMAGE APPRAISAL SYSTEM

The data in Table 1 were derived from 150 random quarter-acre plot tallies on 41 recent burns in the mountains of North Carolina, Virginia, West Virginia, Kentucky and Tennessee, and from four large, permanent, burned-over experimental plots in North Carolina and Georgia.

From the records taken on these plots, the total volume of trees of sawtimber size, dead and dying because of fire, was assigned a value based on the long-time, average stumpage prices in Table 2. The damage resulting from the fire-killing of trees below sawtimber size was measured in terms of delayed income to the timber owner and was determined by computing the difference between two discounted values: (1) the value of the predicted yield^{3/} at the time a merchantable cut would have

^{3/}Forecasts of the time to reach sawtimber size were based on growth curves for many species presented in the following reference: Barrett, L. I. - Growth rate of northern white pine in the southern Appalachians. Jour. For. 31: 570-572, May 1933.

Table 2.-Average stumpage values.

Species	Value per M board feet
Yellowpoplar and black cherry.	\$ 9.00
Northern red, white and post oaks; basswood; ash; sugar maple; and black locust.	8.00
White pine and shortleaf pine.	5.00
Black and chestnut oaks; red maple; and red gum.	3.00
Pitch and Virginia pines; black gum; beech; hickory; hemlock; buckeye; southern red; and scarlet oaks.	2.00

been produced, if the area had not burned, and (2) the value of the predicted yield of the burned stand at the time a merchantable cut would be produced, based on the assumption that replacement of killed trees would follow promptly after the burn. In computing the future value of dead and dying trees (from stumpage prices given in Table 2), a value was placed only on those trees that obviously would have a place in the final crop. Thus, fire-killed trees that probably would have died because of future suppression were eliminated in computing expected yields. The present worth of expected yields was determined by discounting future values at 3 percent interest, compounded annually.

The damage from cull in wounded trees was determined by discounting the value of the predicted cull volume which would be present when

the wounded trees became merchantable.^{4/}

Damage caused by lowered diameter growth was based on the reduction in future merchantable volume per acre of stands containing fire-wounded scarlet oak, and the discounted value of the loss in volume. Scarlet oak was the only species studied which showed a significant reduction in growth of surviving individual trees as a result of basal wounding. Therefore, losses from this source are influenced only by the average representation of wounded scarlet oak in the various types and condition classes.

The total damages resulting from these losses were segregated into classes representing variations in fire intensity, condition class, type and degree of stocking, and the average damage figure for each class entered in Table 1.

Study of the computational methods described briefly above shows that the nature of fire damage in Appalachian types was considered as twofold. First, immediate losses resulting from the fire-killing of trees of sawlog size, the value of which can easily be determined by applying to estimated killed volumes reasonable stumpage values such as those given in Table 2. Trees under sawlog size were not considered to have present stumpage values because markets for small size products in the mountains are comparatively limited, and the demand for given species varies from time to time. Therefore, no realistic average stumpage

^{4/}Hepting, George H., Division of Forest Pathology, Bureau of Plant Industry. - The prediction of cull following fire in Appalachian oaks. Submitted to Jour. Agr. Res.

values can be applied generally to trees below sawtimber size. Second, delayed losses resulting from cull and lowered future sawtimber volumes caused by the killing of trees too small to have current market value, and reduced growth rates of some surviving trees. Admittedly, the method, previously described, of discounting future losses to determine their present worth is controversial, but is believed to represent a fair valuation of those losses, none the less real simply because they are delayed. It is not yet known if this method of computing damage would be held valid by any present court in a suit for the collection of fire damages. However, in this connection it is interesting to note that one threatened suit has already been settled out of court on the basis of an appraisal made by use of Table 1.

HOW TO USE THE FIRE DAMAGE APPRAISAL TABLE

Each figure in Table 1 shows the amount of damage in dollars caused by an average fire on one acre of woodland. The table contains 72 figures, and the appraiser's job is to determine which to use, based either on his best judgment or on actual surveys of the burned area. Irrespective of the method used, application of Table 1 requires evaluation of the following four factors:

1. Fire Severity

Use fire danger class from the nearest danger station, on the day and hour when the fire made its greatest run. If danger ratings are not available, estimate the fire severity to be low, medium, high, or extreme.

2. Condition Class

A. Decide whether the net volume of sawlog size trees on the average acre before the fire was above or below 600 board feet. Sawlog size trees must have at least the following diameters at breast height:

- 9 inches -- all pines.
- 11 inches -- cherry, ash, basswood, and yellowpoplar.
- 13 inches -- all oaks, and other commercial hardwoods.

B. (a)-When this volume per acre is at least 600 board feet, the condition class is sawlog.

(b)-When this volume per acre is less than 600 board feet, the condition class is under-sawlog.

(c)-When there are no sawlog size trees on the area, the condition class is without question, under-sawlog.

3. Forest Type

Forest type is based on the number of stems of pine or hardwood trees of commercial species tall enough to be in the upper crown level. Undergrowth is not considered, nor trees that are so low as to be completely shaded.

A. When at least three-quarters of the upper crown level is composed of hardwood trees -- the type is Hardwood.

B. When at least three-quarters of the upper crown level is composed of pine trees -- the type is Pine.

C. When either pines or hardwoods comprise more than one-quarter of the trees in the upper crown level, but less than three-quarters -- the type is Pine-hardwood.

4. Degree of Stocking

Degree of stocking is based on the approximate net volume present on the average acre before the fire, according to the condition class and forest type.

A. When the condition class is sawlog:

(a) Estimate which of the three ranges of net board-foot volume (Table 3) most nearly represents the volume on the average acre of the burned area. Only trees of commercial species, and of the sawlog sizes given under Condition Class, should be considered in making this stocking classification.

(b) Using this volume range, refer to the figures in Table 3 for the sawlog condition class and the forest type decided on, to determine whether stocking is good, medium, or poor.

B. When the condition class is under-sawlog:

(a) Estimate which of the three ranges of net cordwood volume in Table 3 most nearly represents the volume on the average acre of the burned area. Only trees of commercial species, and those 5 inches in diameter at breast height, or larger, should be considered in making this classification.

(b) Using this volume range, refer to the figures in Table 3 for under-sawlog condition class and the forest type decided on, to determine whether stocking is good, medium, or poor.

Table 3.^{1/}

Type	: Sawlog condition class			: Under-sawlog condition class		
	: (Net volume in board feet			: (Net volume in standard		
	: per acre in trees of sawlog			: cords ^{2/} per acre--trees 5.0"		
	: size)			: d.b.h. and larger)		
	: Poor	: Medium	: Good	: Poor	: Medium	: Good
Hardwood	600	1,000	2,900	0	1	5
	to	to	+	to	to	+
	1,000	2,900		1	5	
Pine- hardwood	600	1,300	3,700	0	1	6
	to	to	+	to	to	+
	1,300	3,700		1	6	
Pine	600	1,800	4,600	0	1	7
	to	to	+	to	to	+
	1,800	4,600		1	7	

^{1/}Adapted from Forest Survey data, North Carolina Mountain Region.

^{2/}Refers to a stack of wood 8 feet long and 4 feet high made up of sticks 4 feet long, the stack occupying 128 cubic feet of space.

Because timber stand conditions are usually more uniform, it is easier to determine damage on small fires, especially those under 10 acres, than on the larger fires. For example, assume that a 5-acre fire made its greatest run at 2:00 p.m. through a stand of almost pure pine, containing between 600 and 1,800 board feet on the average acre. Assume fire severity to have been medium, because fire danger from the nearest station at 2:00 p.m. was class 3. The type is pine because well over three-quarters of the upper crown level is composed of pine trees. The condition class is sawlog because the average acre has over 600 board feet. The stocking is poor as shown in Table 3. In Table 1 opposite poor stocking, in the pine type, and under class 3, sawlog, is the damage figure of \$0.85. This figure multiplied by 5 equals \$4.25, total "tangible" damage caused by this 5-acre fire.

If the fire burned 50 acres instead of 5, the job of appraisal would probably be more difficult, and would require exercise of more judgment. For example, some of the burned area might be in a hollow where the fire severity dropped to "low", or it might burn through the pure pine stand and include 20 acres of mixed pine-hardwood, and it is probable that some of the additional acreage might be under-sawlog condition class, with medium or good stocking. When a single burn covers a variety of types, condition classes and fire severities, two general approaches are possible in appraising fire damage. The first approach is to base the appraisal on the prevailing type, condition class, degree of stocking and severity of burn. This method requires determination of the four factors in terms of broad averages for the whole burn, and

the appraisal would be similar to the example first given. However, the second and more accurate approach would be to break the area into units within each of which fairly uniform conditions exist. For example, an appraiser after looking over a 50-acre burn might decide that it should be divided into the following units:

Unit 1.	20 acres	--	fire severity.....	medium
			condition class.....	under-sawlog
			type.....	pine
			stocking.....	medium
Unit 2.	20 acres	--	fire severity.....	medium
			condition class.....	under-sawlog
			type.....	pine-hardwood
			stocking.....	good
Unit 3.	10 acres	--	fire severity.....	low
			condition class.....	sawlog
			type.....	pine
			stocking.....	poor

Damage for Unit 1. -- In the damage table opposite medium stocking in the pine type, and under class 3, under-sawlog, is the damage figure of \$0.90. This figure multiplied by 20 acres equals \$18.00.

Damage for Unit 2. -- In the damage table opposite good stocking in the pine-hardwood type, and under class 3, under-sawlog, is the damage figure of \$1.50. This figure multiplied by 20 acres equals \$30.00.

Damage for Unit 3. -- In the damage table opposite poor stocking in the pine type, and under class 2, sawlog, is the damage figure of \$0.30. This figure multiplied by 10 acres equals \$3.00.

The total damage caused by this 50-acre fire would be the sum of \$18.00, \$30.00 and \$3.00, or \$51.00.

In some cases, a fire may include open areas or grassland. Such areas that do not contain at least 80 healthy, commercial tree seedlings should be considered as non-forest, and not included in the damage estimates.

A suggested form is attached for convenience in reporting fire damage. This form may prove helpful on the larger fires, where appraisal of damage on several separate units of the burn may be considered desirable.

In conclusion it should be emphasized that Table 1 is a first attempt at presenting a summary of careful but initial studies of many complex relationships. Every effort has been made to reduce the number of factors which must be evaluated in order to make realistic damage appraisals. Even with these efforts at simplification some readers may have justification for feeling that the methods required to apply the damage figures are too complex for practical purposes. For example, perhaps the breakdown by three degrees of stocking might be entirely eliminated. This was not done in Table 1 because of the differences in damage between various degrees of stocking on the more severe burns. If readers, who feel that these recommendations for damage appraisal are too complex, will advise the Appalachian Forest Experiment Station of the method of appraisal now in use and the reasons why the method proposed in this note is not adapted to the particular locality or organization, it may be possible to revise Table 1 for more ready application.

RS-AP
FIRE
Effects
Form 20

INDIVIDUAL FIRE DAMAGE REPORT

Forest _____ District _____ Date of fire _____
Name of fire _____ Time of greatest run _____ AM-PM

UNIT 1

Danger class (fire severity) _____
Condition class _____
Forest type _____
Degree of stocking _____
Acres in unit _____
Damage per acre _____
Unit damage _____

UNIT 2

Danger class (fire severity) _____
Condition class _____
Forest type _____
Degree of stocking _____
Acres in unit _____
Damage per acre _____
Unit damage _____

UNIT 3

Danger class (fire severity) _____
Condition class _____
Forest type _____
Degree of stocking _____
Acres in unit _____
Damage per acre _____
Unit damage _____

UNIT 4

Danger class (fire severity) _____
Condition class _____
Forest type _____
Degree of stocking _____
Acres in unit _____
Damage per acre _____
Unit damage _____

Total acreage of damage _____ Total damage _____ \$ _____

Remarks:

Appraiser